

What is claimed is:

[Claim 1] A variable phase shifter module, comprising:

a first main PCB having an input trace coupled to a first wiper junction;
a first arcuate trace extending between a first output trace and a second output trace on the first main PCB, the first arcuate trace having an arc center proximate the first wiper junction; and
a first wiper PCB having a linking trace thereon; the wiper PCB rotatably coupled to the first main PCB proximate the first wiper junction with the linking trace facing the first main PCB;
the linking trace coupling the first wiper junction with the first arcuate trace.

[Claim 2] The apparatus of claim 1, further including a second arcuate trace extending between a third output trace and a fourth output trace; the second arcuate trace having an arc center proximate the first wiper junction.

[Claim 3] The apparatus of claim 1, further including a fifth output trace coupled to the first wiper junction.

[Claim 4] The apparatus of claim 1, further including an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the first wiper PCB against the first main PCB, about the arcuate edge guide surface.

[Claim 5] The apparatus of claim 1, further including an arcuate guide slot formed in the first main PCB having an arc center proximate the first wiper junction; and a fastener extending through the guide slot and a guide hole formed in the first wiper PCB to bias the wiper against the first main PCB.

[Claim 6] The apparatus of claim 1, wherein the first output trace and second output trace have a width and length adapted for a desired power division and pre-set phase shift differential.

[Claim 7] The apparatus of claim 1, wherein one of the first main PCB, the first wiper PCB and both of the first main PCB and the first wiper PCB have a dielectric coating.

[Claim 8] The apparatus of claim 1, further including a second main PCB with a second wiper PCB coupled proximate a second wiper junction; the wiper rotatably coupled to the second printed circuit board proximate the second wiper junction; the first wiper junction and the second wiper junction aligned in a spaced apart coaxial orientation.

[Claim 9] The apparatus of claim 8, wherein the first wiper PCB and the second wiper PCB are coupled together, commonly movable via a linkage arrangement.

[Claim 10] The apparatus of claim 9, wherein the linkage arrangement is a linkage pin joining the first clip to the second clip, the linkage pin passing through a linkage slot formed in a linkage plate of a linkage arm.

[Claim 11] The apparatus of claim 8, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB each facing the baseplate.

[Claim 12] The apparatus of claim 8, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB arranged facing away from each other.

[Claim 13] The apparatus of claim 8, further including an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the wiper against the first main PCB, about the arcuate edge guide surface.

[Claim 14] The apparatus of claim 1, wherein the wiper PCB has an epoxy glass substrate.

[Claim 15] The apparatus of claim 1, wherein the wiper PCB has a linkage slot formed in a distal end.

[Claim 16] A variable phase shifter module, comprising:

a first main PCB having an input trace coupled to a first wiper junction;
a first arcuate trace extending between a first output trace and a second output trace on the first main PCB, the first arcuate trace having an arc center proximate the first wiper junction;
a second arcuate trace extending between a third output trace and a fourth output trace; the second arcuate trace having an arc center proximate the first wiper junction; a first wiper PCB having a linking trace thereon; the wiper PCB rotatably coupled to the first main PCB proximate the first wiper junction with the linking trace facing the first main PCB; and
an arcuate edge guide surface formed in the first main PCB having an arc center proximate the first wiper junction; and a clip coupled to the wiper to bias the first wiper PCB against the first main PCB, about the arcuate edge guide surface;
the linking trace coupling the first wiper junction with the first arcuate trace and the second arcuate trace.

[Claim 17] The apparatus of claim 16, further including a second main PCB with a second wiper PCB coupled proximate a second wiper junction;
the wiper rotatably coupled to the second printed circuit board proximate the second wiper junction;
the first wiper PCB and the second wiper PCB coupled together;
the first wiper junction and the second wiper junction aligned in a spaced apart coaxial orientation.

[Claim 18] The apparatus of claim 17, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB each facing the baseplate.

[Claim 19] The apparatus of claim 17, further including a base plate to which the first PCB and second PCB are coupled; a trace side of the first PCB and of the second PCB arranged facing away from each other.

[Claim 20] The apparatus of claim 16, further including a linkage slot formed in the distal end of the first wiper PCB.

[Claim 21] A low-height panel antenna comprising:
an array of radiating elements;
a feed network connecting a signal input to said array of radiating elements;
and
a phase shifter assembly located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements, said phase shifter assembly comprising a moveable conductive component coupled to the input and capacitively coupled to a transmission line segment of the network between radiating elements, the wiper conductive component or transmission line segment having a dielectric coating providing dielectric separation of the transmission line segment and the wiper conductive component.

[Claim 22] The antenna of claim 21 wherein said moveable conductive component comprises a conductive trace on a PC board wiper body, the trace being located on the side of the wiper body facing the transmission line segment.

[Claim 23] The antenna of claim 22 wherein said transmission line segment is configured as a segment of a circle and wherein said wiper body is pivoted at the center of the circle.

[Claim 24] The antenna of claim 22 wherein said wiper body includes an extension adapted for coupling to a phase shifter adjustment linkage.

[Claim 25] The antenna of claim 21 wherein said dielectric coating is composed of soldermask or an organic compound.

[Claim 26] A low-height phase shifter assembly adapted to adjust the phasing of signals fed through a transmission line network to an array of antenna radiating elements, said phase shifter assembly having a moveable wiper comprising a dielectric substrate with a conductive layer on a surface of the substrate facing and spaced from a segment of the transmission line.

[Claim 27] The phase shifter assembly of claim 26 wherein said dielectric substrate comprises a PC board and said conductive layer is a trace formed on the said surface of the PC board.

[Claim 28] The phase shifter assembly of claim 27 wherein said trace has a coating composed of dielectric material.

[Claim 29] The phase shifter assembly of claim 28 wherein said dielectric coating comprises soldermask or organic material.

[Claim 30] The phase shifter assembly of claim 26 wherein said dielectric substrate is configured to be coupled to a phase shifter adjustment linkage.

[Claim 31] A low-height panel antenna comprising:

an array of radiating elements;

a feed network connecting a signal input to said array of radiating elements;
and

a low-height phase shifter assembly as described in claim 200 located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements.

[Claim 32] The panel antenna of claim 31 including a predetermined plurality of arrays of radiating elements, and a corresponding plurality of said phase shifter assemblies arranged in a stack to control signal phasing in said plurality of arrays of radiating elements.

[Claim 33] The panel antenna of claim 31 having a coupling arrangement configured to couple said plurality of phase shifter assemblies together and to a phase shifter adjustment linkage such that movement of the linkage moves said plurality of phase shifter assemblies together as one unit.

[Claim 34] A low-height phase shifter assembly adapted to adjust the phasing of signals fed through a transmission line network to an array of antenna radiating elements, said phase shifter assembly comprising a moveable conductive component coupled to a signal input and capacitively coupled to a segment of the transmission line network between radiating

elements, the wiper conductive component or transmission line segment having a dielectric coating providing dielectric separation of the transmission line segment and the wiper conductive component.

[Claim 35] The phase shifter assembly of claim 34 wherein said moveable conductive component comprises a conductive trace on a PC board wiper body, the trace being located on the side of the wiper body facing the transmission line segment.

[Claim 36] The phase shifter assembly of claim 35 wherein said transmission line segment is configured as a segment of a circle and wherein said wiper body is pivoted at the center of the circle.

[Claim 37] The phase shifter assembly of claim 35 wherein said wiper body includes an extension adapted for coupling to a phase shifter adjustment linkage.

[Claim 38] 37. The phase shifter assembly of claim 34 wherein said dielectric coating is composed of soldermask or organic material.

[Claim 39] A low-height panel antenna comprising:

an array of radiating elements;

a feed network connecting a signal input to said array of radiating elements;

and

a low-height phase shifter assembly as described in claim 300 located in said feed network and configured to adjust the phasing of signals fed to said array of radiating elements.

[Claim 40] The panel antenna of claim 39 including a predetermined plurality of arrays of radiating elements, and a corresponding plurality of said

phase shifter assemblies arranged in a stack to control signal phasing in said plurality of arrays of radiating elements.

[Claim 41] The panel antenna of claim 39 having a coupling arrangement configured to couple said plurality of phase shifter assemblies together and to a phase shifter adjustment linkage such that movement of the linkage moves said plurality of phase shifter assemblies together as one unit.